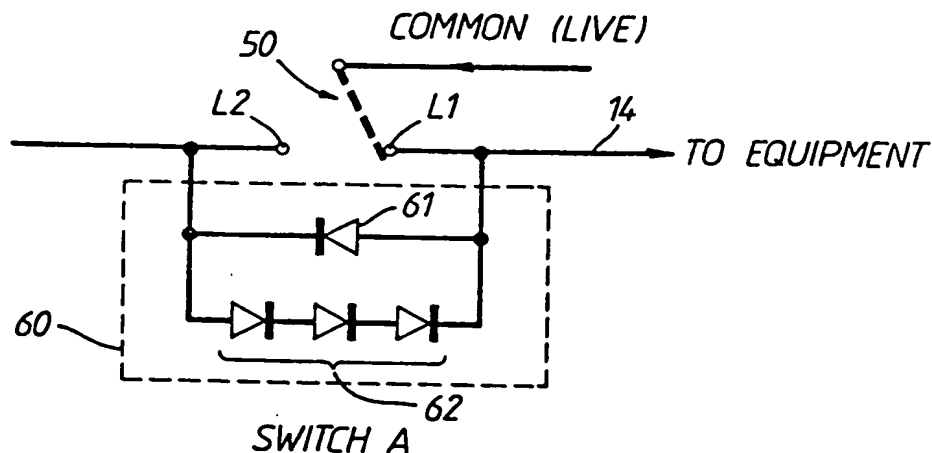




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/GB93/00409 (22) International Filing Date: 26 February 1993 (26.02.93)  (30) Priority data: 9204416.3                      29 February 1992 (29.02.92)    GB 9218894.5                      7 September 1992 (07.09.92)    GB  (71) Applicant (for all designated States except US): SCAN- TRONIC LIMITED [GB/GB]; Perivale Industrial Park, Greenford, Middlesex UB6 7RJ (GB).  (72) Inventor; and (75) Inventor/Applicant (for US only): MOORE, Robert, William [GB/GB]; 5 Pen Yr Allt Rheola, Resolven, West Glam- organ SA11 4DS (GB).	(74) Agent: CRAWFORD, Andrew, Birkby; A.A. Thornton & Co., Northumberland House, 303-306 High Holborn, London WC1V 7LE (GB).  (81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DE (Utility model), DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).  Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.  (88) Date of publication of the international search report: 28 October 1993 (28.10.93)	

(54) Title: POWER SUPPLY AND SMOKE SENSOR FOR ALARM SYSTEM



## (57) Abstract

An alarm is provided in association with a ceiling rose. In order to provide the alarm with substantially continuous power while still allowing the light to be switched on/off the normal power supply lines are used together with a special light switch. Operation of the light switch produces a modification in the waveform of the AC power supplied to the ceiling rose. This modification is detected by a sensing circuit at the ceiling rose. The sensing unit controls the switching of the light. Preferably the AC power waveform is modified by creating an imbalance between the positive and negative half-cycles of the waveform. This imbalance may be compensated using a balancing circuit at the ceiling rose. By altering the polarity of the imbalance created in the AC waveform it is possible to signal to the sensing circuit that a further switchable unit, e.g. a ceiling fan, connected to the sensing circuit should be switched. If the alarm is a smoke alarm or the like then it is preferred to promote circulation of air within the casing of the unit, as well as to improve the draw of air into the casing, using a heating means and a special arrangement of air flow passages.

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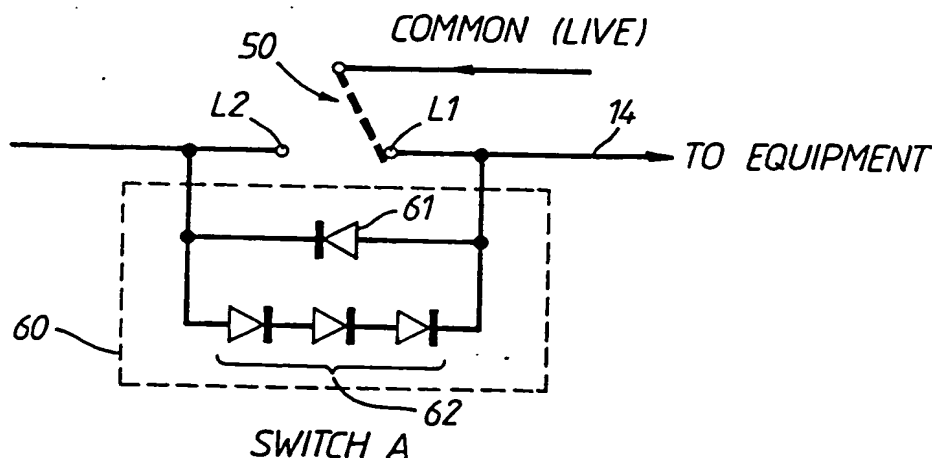
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## POWER SUPPLY AND SMOKE SENSOR FOR ALARM SYSTEM

This invention relates to an alarm, particularly but not solely to a smoke alarm, and to a switching arrangement which may be used in conjunction with units such as alarms.

Smoke alarms are known for mounting to ceilings, these smoke alarms commonly being small, self-contained, battery-powered units. The batteries need to be replaced periodically to maintain the alarm in an operable condition. However, many deaths and injuries have been caused by fire where the smoke alarm has failed to operate owing to its battery having discharged.

Smoke alarms are also rather unsightly items and many people prefer not to fit them rather than to have an alarm mounted to a ceiling e.g. in their living room.

Intruder detection alarms similarly suffer from being considered unsightly and failing to operate when needed because of exhaustion of batteries.

GB-A-2221074 provides a smoke alarm in which both of the above problems can be overcome. This is achieved by incorporating the smoke alarm into, or fitting it to, the ceiling rose of a pendant light. The alarm may be battery powered, but preferably it is powered from a mains supply which is fed to the ceiling rose. A disadvantage with this arrangement is that a permanent live supply has to be provided for the alarm in addition to the switched supply for the pendant light.

Although in some newly-wired buildings a permanent live supply will be present in each ceiling rose, this is not the case in older buildings nor according to the most recent wiring regulations. In the latter cases only a switched live supply is provided to the ceiling rose and the supply of current is dependent

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upon the status of the associated light switch. In such systems it would be difficult to fit an alarm of the sort described in GB-A-2221074.

We have now devised an arrangement which alleviates the above problem with the above mentioned smoke alarm.

In accordance with a first aspect of the invention there is provided a switching arrangement comprising an actuator having one terminal for connection to an AC power supply and a second terminal connected by a line to a sensing means, the actuator being arranged to modify the waveform of the AC power passing to the sensing means and the sensing means being arranged to detect modifications in said waveform to selectively connect or disconnect said line to one or more electrical outputs while allowing power from the line to be fed substantially continuously to a further electrical output.

The invention in its first aspect provides the advantage that the system allows the use of the same circuitry and switchgear to independently switch one or two different devices connected to the same wiring circuit and to power a further device or devices which require substantially continuous power. Thus, a mains power cable to a ceiling rose can provide switching information to turn the light on or off and also provide stable AC power to an associated unit such as a smoke alarm.

Embodiments of the invention have the advantage that the on/off status of the switchable device(s) attached to the sensing means is not affected by a supply failure. Operation of the actuator during the period of the supply failure will not be detected by the sensing means and so will not alter the on/off state of the switchable device(s). When the power supply is restored then the switchable device will remain in the on/off state it was prior to the failure.

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In one simple embodiment the present invention may use an actuator which comprises a switch which when operated causes a normally-closed connection between the line and the mains supply to go open-circuit. In such an arrangement the normal situation is that the line is continuously supplied with AC power enabling the smoke alarm associated with the light to function normally. The on/off status of the light does not change while the AC supply remains steady. However when the actuator is operated the sensing means detects the interruption in the supply and changes the status of the light, i.e. selectively connects or disconnects the light to the supply. Obviously, in this simple arrangement the duration of the interruption of the AC power should be brief so as to maintain the cause the least disturbance to the supply of power to the associated smoke alarm. However, it is preferable for the sensing means to react to an interruption lasting at least 2 cycles of mains, preferably 5 cycles, so as to prevent erroneous switching in response to transients.

In more sophisticated embodiments of the invention it is preferred that operation of the switch should cause a change in the form of the AC supply waveform instead of an interruption in the supply. This may be achieved relatively simply by connecting electrical components between the first and second terminals in parallel with a short circuit between the terminals. Operation of a switch interrupts the short circuit between the AC power supply and the line thus bringing the electrical components into operation.

In a first such embodiment of the invention the actuator is arranged to rectify the AC power waveform for a short period of time, and the sensing means is arranged to sense the rectified supply in order to selectively connect or disconnect said line to one or more of said electrical outputs. It is preferred to limit the duration of the modification so that a substantially stable AC power waveform is passed along

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the line and the risk of damage to reactive components is minimised.

In a second, presently preferred embodiment of the invention the actuator is arranged to change the balance between positive and negative half cycles of the AC power waveform. Preferably the difference between cycles is limited so that the AC power available from the line is not substantially altered when there is an imbalance between the cycles.

It is further preferred that a balancing circuit be provided in the sensing means in order to restore the balance between the positive and negative half cycles so that the switching system does not load one half cycle of the mains more than the other half cycle.

In the above-mentioned first and second embodiments it is possible to send two different switching signals depending upon which of the half-cycles of the AC waveform is modified. For example, when the positive half-cycle of the waveform is removed or modified this may constitute a switching signal for a first device associated with the sensing means and when the negative half-cycle is removed or modified then that may constitute a switching signal for a second unit associated with the sensing means. Thus a ceiling rose could have an alarm, a light and a ceiling fan associated with it, the latter two items being separately switchable.

Furthermore when used to control switching of a single device associated with the sensing means these switching methods can ensure a definite polarity of the switch and thus ensure freedom from false switching due to spurious signals, transients or noise which may be present in the supply from other sources.

The second, preferred embodiment of the invention has the advantage that switching is signalled to the sensing means without introducing into the AC supply transient signals, modulations, noise or other effects which may be detrimental to the use of the



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supply. Also, this embodiment can provide two-way switching of the light (or other switchable appliance associated with the sensing means). That is, the switchable device can be controlled from two different switches, e.g. upstairs and downstairs light switches.

The switching action produces only a small voltage change across the switch terminals and in the wires running from the switch to the alarm or any other connected device. This not only reduces arcing and switch contact erosion but can be used as the basis of a "low noise switching system" in certain applications.

Commonly smoke alarms comprise a printed circuit board and a battery mounted inside an openable plastics casing. A smoke detection element and alarm circuitry are mounted on the printed circuit board. In the event of a fire smoke has to enter the casing through slots or holes formed therein, in order to trigger the alarm, but often the circulation into the alarm case is poor.

The second aspect of the invention is based on a recognition that the performance of a smoke alarm may be improved not just by ensuring that ambient air is drawn into the case from the outside but also by improving circulation and mixing within the case.

In accordance with a second aspect of this invention, there is provided a sensor comprising:

- a casing having therein an inlet and an outlet;

- a detecting element mounted in the casing, said detecting element being arranged to detect a change in condition of the air or gas circulating past it;

- a baffle defining an upper and a lower chamber in the casing;

- a first passage allowing air or gas from the lower chamber to pass to the upper chamber; and

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at least one second passage allowing air or gas to pass from the upper chamber to the lower chamber;

wherein the inlet in the casing communicates with the lower chamber and the outlet in the casing communicates with the upper chamber, and means are provided for heating the air or gas entering the casing whereby to promote circulation of air or gas into the casing and to promote circulation of air or gas within the casing.

The second aspect of the invention further provides the above-described sensor combined with a ceiling rose fitment. Tests have been performed which suggest that in such an arrangement circulation of air into the sensor casing is improved when the light is switched on (because of rising air currents). Thus the heating means and specially designed circulation system will show most effect when the light is off. In both cases the intention is to mix the air inside the casing, and to ensure faster exchange of air/gas with the outside atmosphere.

In preferred embodiments of the invention the passages between the upper and lower chambers are arranged such that the first passage is at or near the centre of the casing and the at least one second passage is provided as a set of second passages nearer the sides of the casing. This arrangement promotes circulation within the casing as well as providing good circulation of air or gas into the casing from the outside. Furthermore the inlet and outlet in the sensor casing may be constituted by respective pluralities of inlet and outlet holes.

In preferred embodiments of the invention the baffle is provided by a printed circuit board which carries the electrical components of the sensor. In such embodiments the first passage will usually be a hole through the circuit board and the second passages

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may be formed as holes in the circuit board or by gaps between the perimeter of the circuit board and the sides of the casing.

The heating means may be constituted by the electrical components on the circuit board which heat up during use. Alternatively or additionally a separate heating element may be provided. Advantageously this may be a resistor. In arrangements of the invention which use the heating element it is preferred to position the heating element near the first passage through the circuit board. Thus, in use the heating element remains hot at all times, causes a convection air current to flow through the sensor and therefore draws any smoke or other gases present in the air into the sensor.

The detecting element may be arranged to detect the presence of smoke in the air stream, or the presence of a selected gas, or it may detect a change in condition (e.g. temperature).

Where local fire and safety regulations allow, there are technical benefits to arranging the outlet from the sensor so as to communicate with the ceiling void of a room. This increases the temperature differential between the inlet and outlet thus further promoting circulation of air into the sensor casing.

Some types of smoke alarm, fire alarms or burglar alarms can sound indefinitely until they are reset. This is undesirable especially when the alarm is a false alarm or when the break in or fire has been detected and dealt with a good time before the alarm is reset.

In accordance with a third aspect of this invention, there is provided an alarm system comprising an alarm which emits an audible signal when triggered, and means for automatically reducing the intensity of said audible signal a predetermined period after said alarm is triggered.

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Preferably a plurality of alarms are interconnected so that when any one of said alarms is triggered a plurality of the alarms emit an audible signal. Preferably each alarm comprises means for manually reducing the intensity of its audible signal. Preferably the alarm(s) automatically reset a predetermined period after being triggered.

Embodiments of this invention will now be described by way of examples only and with reference to the accompanying drawings in which:

FIGURE 1 is a sectional view of a first embodiment of actuator for a switching arrangement in accordance with the first aspect of this invention;

FIGURE 2 is a circuit diagram of a modified version of the first embodiment of actuator;

FIGURE 3 is a circuit diagram of a sensing means for sensing AC power waveform modifications caused by the actuator of Figure 1 or Figure 2;

FIGURE 4 is a waveform diagram to explain the operation of the circuits of Figures 2 and 3;

FIGURE 5 shows circuit diagrams of a second preferred embodiment of actuator for a switching arrangement in accordance with the first aspect of this invention, in which:

FIGURE 5a) illustrates single way balance switching;

FIGURE 5b) illustrates two way balance switching in an older two plate wiring system; and

FIGURE 5c) illustrates two way balance switching in a modern three plate wiring system ;

FIGURE 6 shows truth tables to explain the operation of the circuits of Figure 5;

FIGURE 7 is a circuit diagram of a sensing means for sensing AC power waveform modifications caused by the actuators of Figure 5;

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FIGURE 8 is a sectional view of a smoke alarm in accordance with the second aspect of this invention; and

FIGURE 9 is a sectional view of a modified form of the alarm shown in Figure 8.

Referring to Figure 1 of the drawings, there is shown a push-button switch 10 comprising a plastics push-button 12 slidably mounted in a plastics housing 11. Inlet and outlet electrical conductors 13, 14 extend through the wall of the housing and a diode 16 is connected between the conductors 13, 14 inside the housing. A contact arm 15 is connected to the push button 12 for connecting the two conductors 13, 14. A spring 17 biases the contact arm 15 so that an electrical connection is maintained between the conductors 13, 14 when the button 12 is released.

In use when AC mains power is applied to the conductor 13, this AC power will appear on the second conductor 14. If the push-button 12 is pressed the connection between the conductors 13, 14 will break, but the diode 16 will conduct the AC mains power during positive half cycles only. The sensing circuit described below senses the rectified power in the conductor 14 to change the state of a light bulb. The interruption period to the full mains power is sufficiently small to ensure that a smoke alarm connected to conductor 14 will continue to receive sufficient power. However some form of charge storage device may be provided to ensure a continued level of power.

The smoke alarm may contain a step down transformer to power its low voltage circuitry.

Referring to Figure 2 there is shown a circuit which is designed to limit the duration of half-wave rectified power when the push-button 10 is held open-circuit for too long. The circuit provides a fixed period of half-wave rectified mains to the second

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conductor 14 before switching in the negative half-cycles of the mains power using an optical triac 28.

Four diodes 20, 21, 22, 23 are connected in series across the switch 10. A diode 24, resistor 25 and capacitor 26 are also connected across the switch 10. An optical triac 28 has its LED terminals connected across the capacitor 26 and its triac terminals connected across the switch 10.

In use, the circuit of Figure 2 half-wave rectifies the mains AC when the push-button 10 is depressed as shown in Figure 4. A 1.8 volts drop is created between the points A, B and the capacitor 26 starts to charge through resistor 25. When voltage  $V_{CAP}$  across the capacitor 26 reaches the switching voltage  $V_T$  of the optical triac 28, the triac conducts in both directions. Therefore, full wave AC mains is supplied to the conductor 14 after the push-button 10 has been depressed for a period equal to the time constant of the resistor and capacitor 25, 26.

Referring to Figure 3 of the drawings, there is shown a circuit for sensing the periods of half-wave rectified power and for switching a light ON or OFF on alternate such periods. A diode 31 blocks the positive half cycles appearing on the conductor 14, and thus no voltage appears across the voltage divider formed by resistors 32, 33. The diode 34 passes the positive half cycles of the mains power and hence a positive voltage is developed across the voltage divider formed by resistors 35, 36. This positive voltage causes comparators 39 and 37 to switch a negative output to the gate of a flip-flop 40.

During the half-wave rectified period the gate of the flip flop 40 is held negative via the resistor 41 and the output from the comparator 39. When the full-cycle mains reappears on the conductor 14, the flip-flop changes state i.e from high to low, or from low to high.

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The comparator 38 is therefore switched by flip-flop 40 to drive a relay 42 which switches the light ON or OFF.

In an alternative embodiment a resistor, capacitor or other device may be momentarily switched in series with the mains instead of diodes. In this case the sensing device would be modified to sense these different devices. Alternatively it may be arranged to sense an open circuit of a predetermined duration in order to switch the light.

Referring to Figure 5 of the drawings there are shown a number of different arrangements according to a second embodiment of the invention. In this embodiment electrical components are provided which produce an imbalance between the positive and negative half-cycles of the AC waveform.

Fig. 5a illustrates single way balance switching. The switch A comprises an openable contact 50. A diode pack 60 is connected across the terminals of the switch A. The diode pack consists of a series of diodes 62 connected across the openable contact 50 and a single diode 61 connected in anti-parallel across the series of diodes 62.

When the contact 50 is open, i.e. it contacts the terminal L1 as illustrated, then unmodified AC power is fed from the supply to the equipment. When the openable contact 50 contacts terminal L2 then the AC waveform is modified by the diode pack 60 so as to produce an imbalance between the half-cycles of the waveform. During the positive half-cycle of the waveform the series of diodes 62 conduct and during the negative half-cycles the single diode 61 conducts. Each diode introduces a voltage drop (of the order of 0.7 V for silicon diodes). Because different numbers of diodes are in the current path during the different half-cycles of the supply a different voltage drop will be seen between the half-cycles. If there are say ten diodes in the series 62 then there will be a significant

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imbalance between the voltages of the positive and negative half cycles. This imbalance may be detected and used to control switching.

The operation of the circuit of Fig. 5b) will now be described with reference to Figure 6. When both switch A and switch B are closed, mains AC appears on the output 14. Opening switch A allows mains to flow through the diode 61 during negative half cycles and through the series of diodes 62 during positive half cycles. Likewise when switch A is closed and switch B is open there is a similar imbalance but in the opposite sense. When both switch A and switch B are open, as illustrated, then full mains power is again supplied to the output line 14.

The operation of the circuit of Fig. 5c) will now be described with reference to Figure 6. When both switch A and switch B are open, as illustrated, mains flows through the diode 61 during negative half cycles and through the series of diodes 62 during positive half cycles. This produces an imbalance in the AC waveform detectable by a sensing means attached to the output line 14. Likewise when both switch A and switch B are closed then there is a similar imbalance in the AC waveform. When one switch is open and the other closed then full mains power is supplied to the output line 14.

Figure 7 shows a circuit for sensing the mains voltage output by the circuits of Fig. 5a), 5b) or c) in order to determine what the state of the switched output  $V_{\text{SWITCH}}$  should be. The circuit comprises diodes 87, 88 in series with respective capacitors 85, 86 which are charged by the positive and negative half cycles of the mains supply respectively. A balancing potentiometer 89 is connected across the capacitors 87, 88. The potentiometer 89 is adjusted so that the voltage on its output 90 is zero when the capacitor voltages are equal and opposite. A sensing circuit 91 senses the voltage



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on the potentiometer output 90 and switches a relay 92 directly, or via a transistor  $Q_1$ , according to the value of the sensed voltage.

When an imbalance in the mains supply exists a positive or negative voltage exists on the potentiometer output 90, and when the mains supply is balanced zero volts exists on the potentiometer output 90. The sensing circuit 91 operates the relay 92 when zero volts is sensed. Thus it will be appreciated that changing the state of either switch A or switch B will change the state of the switched output  $V_{\text{SWITCH}}$ . Thus the arrangement shown in Figures 5b) and c) can be used as upstairs and downstairs light switches to control a single light connected to  $V_{\text{SWITCH}}$ .

A balancing circuit 93 may be provided which comprises a series of diodes connected in the opposite sense to the diodes mounted in the switch. The diodes are switched into circuit when the relay is actuated so that a load connected to  $V_{\text{SWITCH}}$  will be provided with a balanced AC signal.

The components shown by dashed lines in Fig.7 may be used to modify the basic circuit. The voltage on the potentiometer output is "smoothed" by the combined effect of capacitors  $C_1$ ,  $C_2$  and  $C_3$  so as to reduce the AC component of the voltage. The "smoothed" voltage is then sensed by the circuit 91 which is here configured as a comparator circuit.

Referring to Figure 8 of the drawings there is shown a smoke alarm 50 having a casing 51 fixed to a ceiling 71. A printed circuit board 52 is mounted inside the casing 51 and a smoke detecting element 53 is mounted on the printed circuit board 52. An aperture 58 is formed in the printed circuit board near the centre of the casing, and a resistor 57 is mounted across the aperture 58. Secondary apertures 59 are formed around the periphery of the circuit board. A convenient way of forming the secondary holes 59 is to use a circuit board

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having a peripheral shape different from the internal section of the casing. For example, the casing may be of circular cross-section and the periphery of the circuit board may be hexagonal.

The bottom of the casing 51 is formed with a plurality of inlet holes or slots 55, and the upper side walls of the casing 51 are formed with a plurality of outlet holes or slots 56. A mains conductor 14 connects the alarm 50 to a wall-mounted switch e.g. as shown in Figure 1. The circuit of Figure 4 is preferably mounted on the printed circuit board 52. A cable 54 extends downwardly through the casing 51 to support a pendant light (not shown). The conductors of the cable preferably connect to the relay 42 shown in Figure 3.

In use, the resistor heats up and causes air to rise through the hole 58 in the circuit board. Thus a convection air current is caused to flow from the inlet to the outlet, creating a flow of air past the smoke detecting element 53. Some of the air in the upper chamber re-enters the lower chamber through the secondary holes 59. Thus encouraging good mixing of air/gas within the sensor casing.

Air rising into the upper chamber also leaves the body of the smoke alarm through vents in the upper body moulding, thus allowing more air to enter via the vents in the lower body moulding.

Figure 9 shows a similar smoke alarm 60 and like parts are given like reference numerals. However, in this embodiment an outlet 66 is formed in the top of the casing 61. The outlet 61 feeds through a hole in the ceiling 71 into the ceiling cavity 70. The temperature difference between the room and the cavity 70 helps to promote the air convection current.

The smoke alarms e.g. 50, 60 may be connected to other smoke alarms. The alarms may include a circuit to reduce the intensity of an audible alarm after a predetermined time period. This time period is set to

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ensure that the alarm is heeded, and a switch may be provided in each alarm to individually reduce the intensity of its audible signal. The other connected alarms sensing an alert will cause the alarm to revert to the full intensity audible signal. Any of the alarms which have automatically or manually reduced the intensity of their audible signal will continue to give that level until automatically resetting after a period of time.

An alarm may be preset to its low intensity status before an alarm condition is met. Whilst in this state no alerts will be detected by that alarm, although any other of the connected alarms which detect an alert will trigger the preset alarm.

It will be appreciated that the reduced intensity of the alarm signal minimises the disturbance caused to others, yet gives an ample warning of the alarm condition contained in devices connected to the second conductor.

According to the present invention it is possible to make use of different types and durations of modification of the AC waveform in order to signal to the sensing means that switching of an associated device should be effected. A number of different possible ways of modifying the AC waveform have already been mentioned above. It would also be possible to use further methods, for example the modification may consist in applying a harmonic of the AC power to the line. In that case the sensing means is arranged to sense said harmonic in order to selectively connect or disconnect the line to one or more of said electrical outputs. Preferably the actuator is arranged to supply one or more different harmonics of the AC power waveform in order to control one or more outputs of the sensing means.

It is to be understood also that the duration of the modification of the AC waveform may take

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different values. In many embodiments it is preferable for the duration of the modification to be short so that the power supply to the alarm or the like is affected as little as possible. However, the duration of the modification must be sufficient so that the sensing means can reliably distinguish the modification from other effects on the mains supply.

In principle it would be possible to arrange that the modification of the AC waveform should persist until the next operation of the actuator. The next operation of the actuator would then cause the AC waveform to be restored to its original state or would cause a different modification of the AC power supply, e.g. the polarity of the modification could be altered.

The above description has been given in terms of a switching arrangement in which operation of a switch breaks a short circuit thus bringing into operation electrical components connected in parallel with the short circuit. Arrangements of this type are simple and relatively cheap to make. However, it is feasible from a technical viewpoint to use alternative arrangements.

For example, it is not essential that the switch should directly interact with the circuitry which produces the modification of the AC waveform. The switch may be arranged so that its operation causes the generation of a signal which triggers the operation of modifying section of the actuator. Furthermore, the switch causing modification of the AC waveform could be a time switch. In such a case there is no physical operation of a switch at the time when the modifying section is triggered into action. Digital components could be used in the switching arrangement.

In the arrangements described above in connection with the second embodiment of the invention a diode pack was illustrated in which a series of diodes is connected in parallel with a single diode. It is to

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be understood that the single diode could be replaced by a series of diodes provided that the numbers of diodes in the two series were arranged to produce different voltage drops in the parallel current paths.

Although the invention has been described in terms of providing an alarm in association with a ceiling-mounted light, the same problems and solutions may apply if it is desired to provide an alarm in association with a wall-mounted light fitting. In such circumstances circulation of air through the alarm may be improved by providing an air outlet in communication with the other side of the wall, e.g. into the wall cavity.

Although the specific description has been given in terms of a ceiling rose/smoke alarm it is to be understood that the smoke alarm could be replaced by a different device, or more than one device could be used, requiring substantially continuous power. Further, it is to be understood that the switching arrangement of the present invention is of general application. In particular, the invention will be useful in various situations where it is desired to use power supply lines to send switching signals as well as power.

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CLAIMS:

1. A system for supplying switched and substantially continuous power, comprising an actuator and a sensing means, the actuator having one terminal for connection to an AC power supply and a second terminal for connection by a line to the sensing means, the actuator being arranged in use to respond to operation of a switch so as to modify the waveform of the AC power passing to the sensing means and the sensing means being arranged to detect modifications in said waveform to selectively connect or disconnect said line to one or more electrical outputs.
2. The system of claim 1, wherein the actuator is adapted to modify the AC waveform by rectifying the waveform.
3. The system of claim 1, wherein the actuator is adapted to modify the AC waveform by producing an imbalance between the half-cycles of the waveform.
4. The system of claim 2 or 3, wherein the actuator is adapted selectively to produce two different modifications of the AC waveform whereby to signal different switching requirements to the sensing means.
5. The system of claim 4, wherein the different modifications of the AC waveform are of different polarities.
6. The system of claim 3, 4 or 5, further comprising a balancing circuit at or downstream of the sensing means for restoring the balance between the positive and negative half cycles of the AC waveform.

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7. The system of claim 6, wherein the actuator is adapted to replace a light switch and the sensing means is adapted to selectively connect or disconnect said line to a light.

8. The system of claim 7, wherein the one or more further electrical outputs include an output to supply an alarm device.

9. The system of claim 8, wherein the alarm device is provided combined in a unit with a ceiling rose fitment.

10. An actuator for use in a system for providing switched and substantially continuous power, the system comprising the actuator and a sensing means, the actuator having one terminal for connection to an AC power supply and a second terminal for connection by a line to the sensing means, the actuator being arranged in response to operation of a switch to modify the waveform of the AC power supplied to said line whereby to signal to the sensing means that said line should be selectively connected to or disconnected from one or more electrical outputs.

11. The actuator of claim 10, adapted to modify the AC waveform by rectifying the waveform.

12. The actuator of claim 10, adapted to modify the AC waveform by producing an imbalance between the half-cycles of the waveform.

13. The actuator of claim 11 or 12, adapted selectively to produce two different modifications of the AC waveform whereby to signal different switching requirements to the sensing means.

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14. The actuator of claim 13, wherein the different modifications of the AC waveform are of different polarities.

15. The actuator of any of claims 10 to 14, configured as a light switch.

16. Sensing means for a system for supplying switched and substantially continuous power, the system comprising the sensing means and an actuator adapted in response to operation of a switch to modify the waveform of AC power passing to the sensing means, the sensing means being adapted to detect modifications in said waveform to selectively connect or disconnect said line to one or more electrical outputs.

17. The sensing means of claim 16, adapted to detect rectification of the AC waveform.

18. The sensing means of claim 16, adapted to detect an imbalance between the half-cycles of the AC waveform.

19. The sensing means of any of claims 16 to 18, and further comprising a balancing circuit for restoring the balance between the positive and negative half cycles of the AC waveform.

20. A sensor comprising:

a casing having therein an inlet and an outlet;

a detecting element mounted in the casing, said detecting element being arranged to detect a change in condition of the air or gas circulating past it;

a baffle defining an upper and a lower chamber in the casing;



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a first passage allowing air or gas from the lower chamber to pass to the upper chamber; and

at least one second passage allowing air or gas to pass from the upper chamber to the lower chamber;

wherein the inlet in the casing communicates with the lower chamber and the outlet in the casing communicates with the upper chamber, and means are provided for heating the air or gas entering the casing whereby to promote circulation of air or gas into the casing and to promote circulation of air or gas within the casing.

21. The sensor of claim 20, wherein the baffle is a circuit board bearing electrical components of the sensor.

22. The sensor of claim 20, wherein the first passage is provided generally centrally within the casing and the at least one second passage comprises a set of second passages provided nearer the sides of the casing.

23. The sensor of claim 22, wherein the baffle is a circuit board bearing electrical components of the sensor and the passages are constituted by holes in the circuit board and/or gaps between the circuit board and the sides of the casing.

24. The sensor of claim 21 or 23, wherein the heating means is constituted by components on the circuit board which heat up during operation of the sensor.

25. The sensor of claim 23, wherein the heating means is a heating element provided proximate the first passage.

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26. The sensor of any of claims 20 to 25, wherein either or both of the inlet and outlet in the sensor casing may be constituted by a plurality of holes.

27. The sensor of any of claims 20 to 26, provided in association with a ceiling rose fitment.

28. The sensor of any of claims 20 to 27, wherein said sensor is a smoke sensor.

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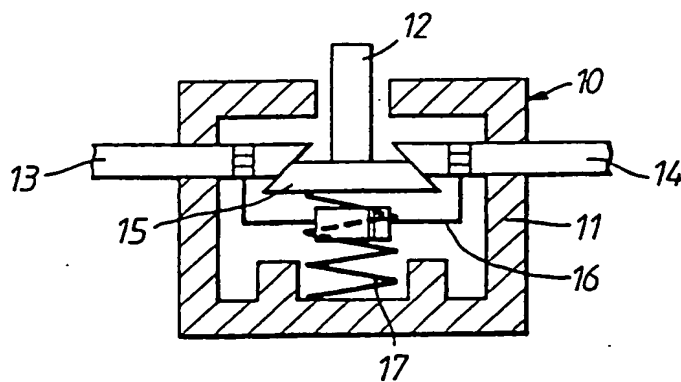


Fig.1.

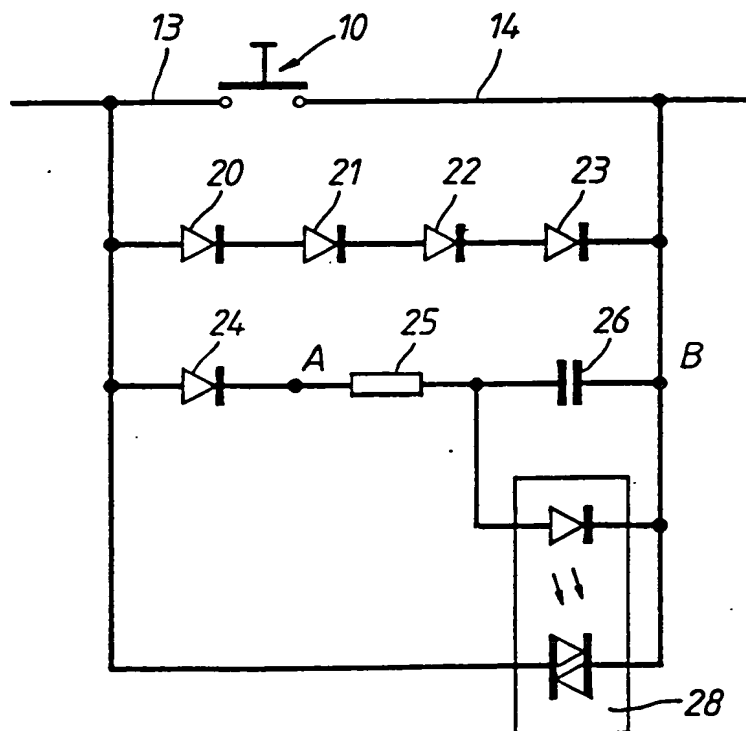


Fig.2.

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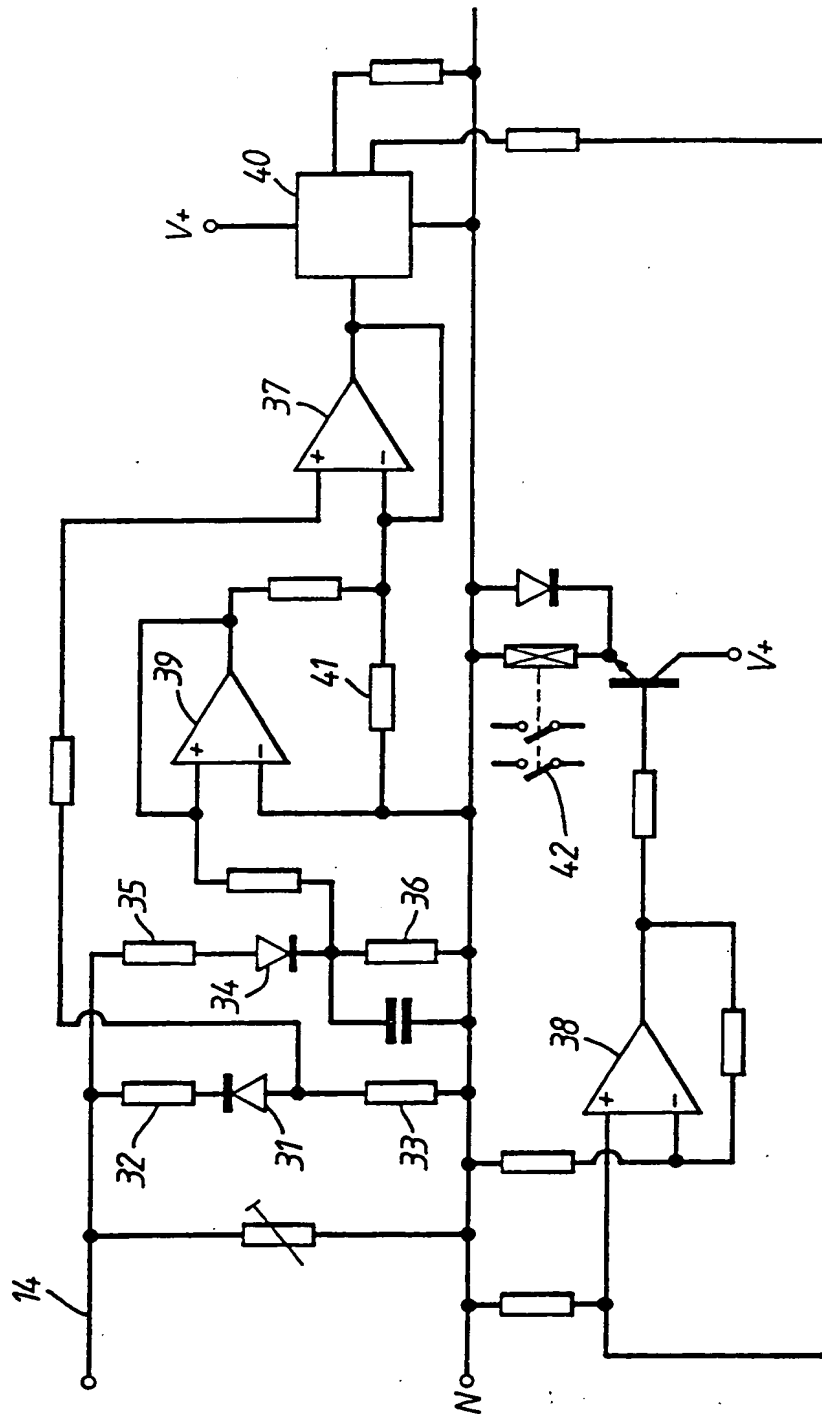


Fig.3.

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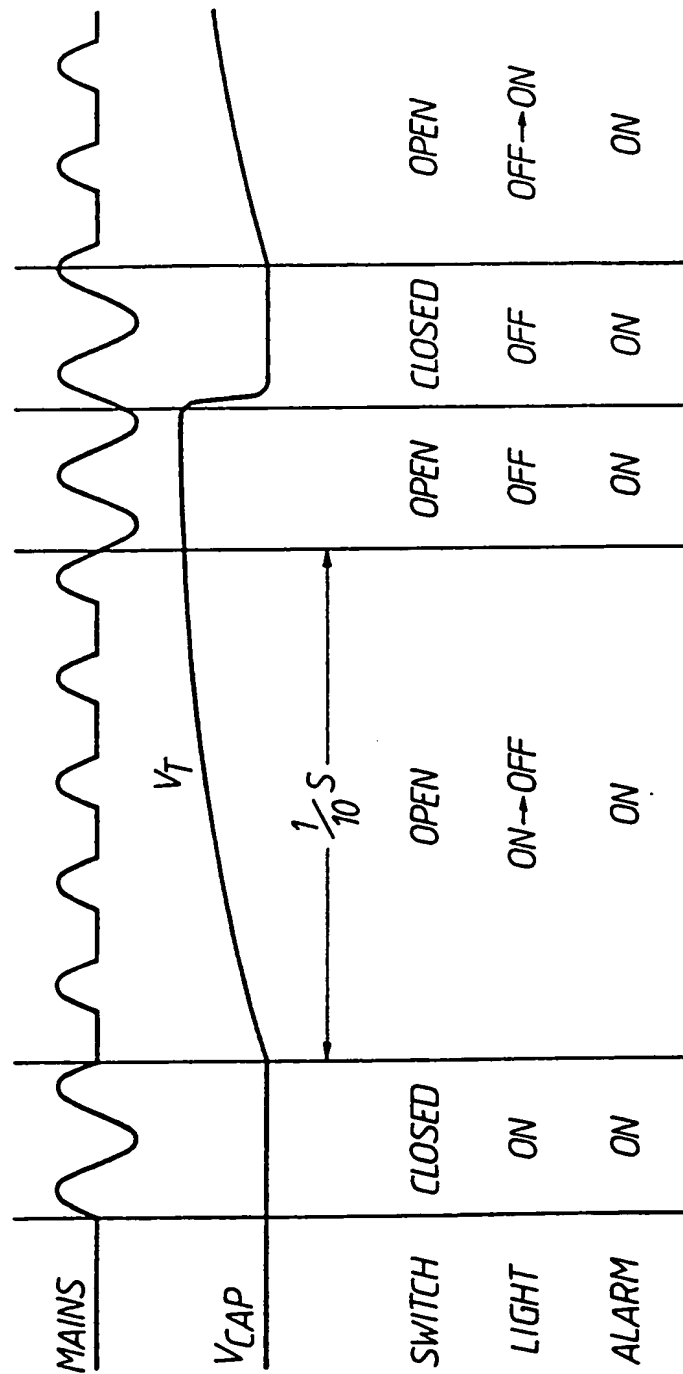


Fig.4.

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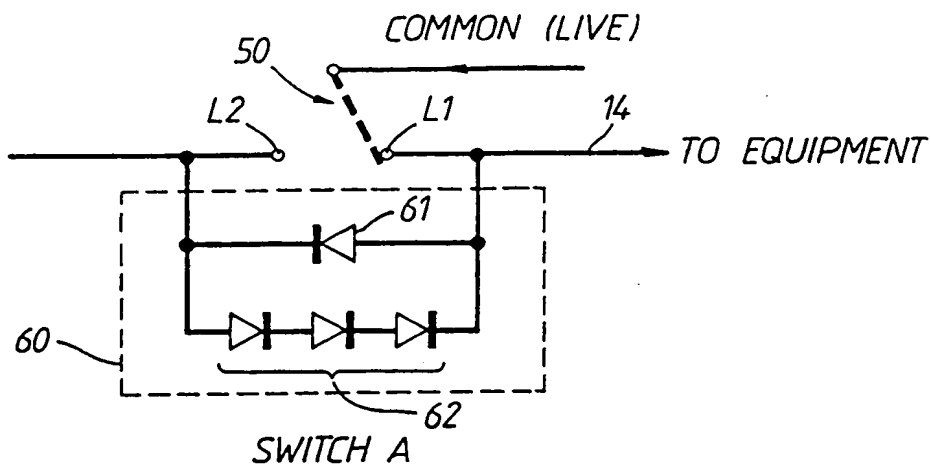


Fig.5(a).

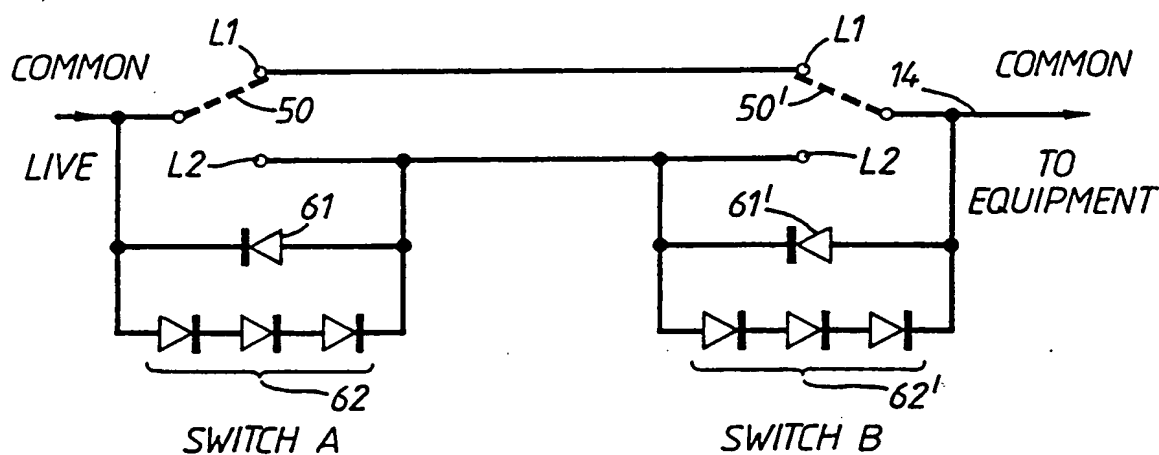


Fig.5(b).

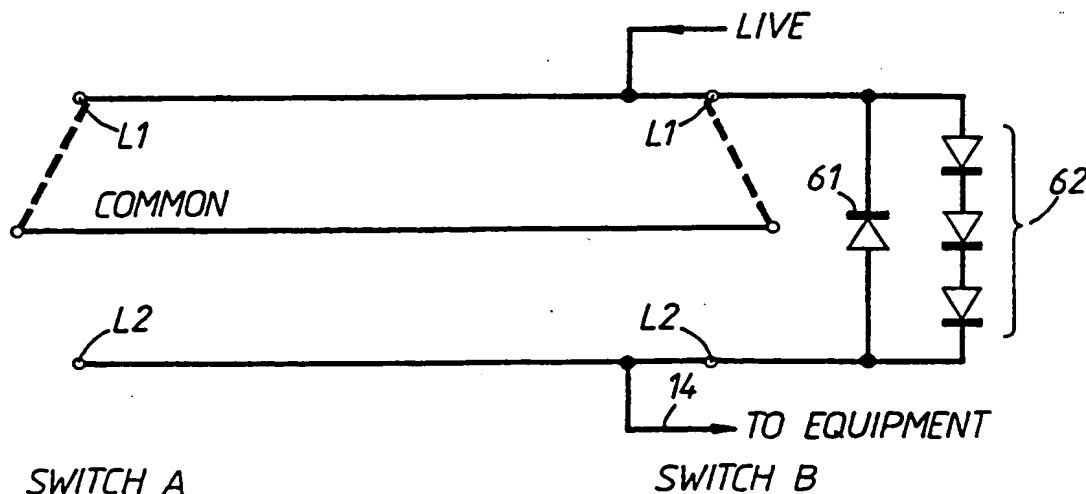


Fig.5(c).

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TRUTH TABLE FOR FIG.5(b).

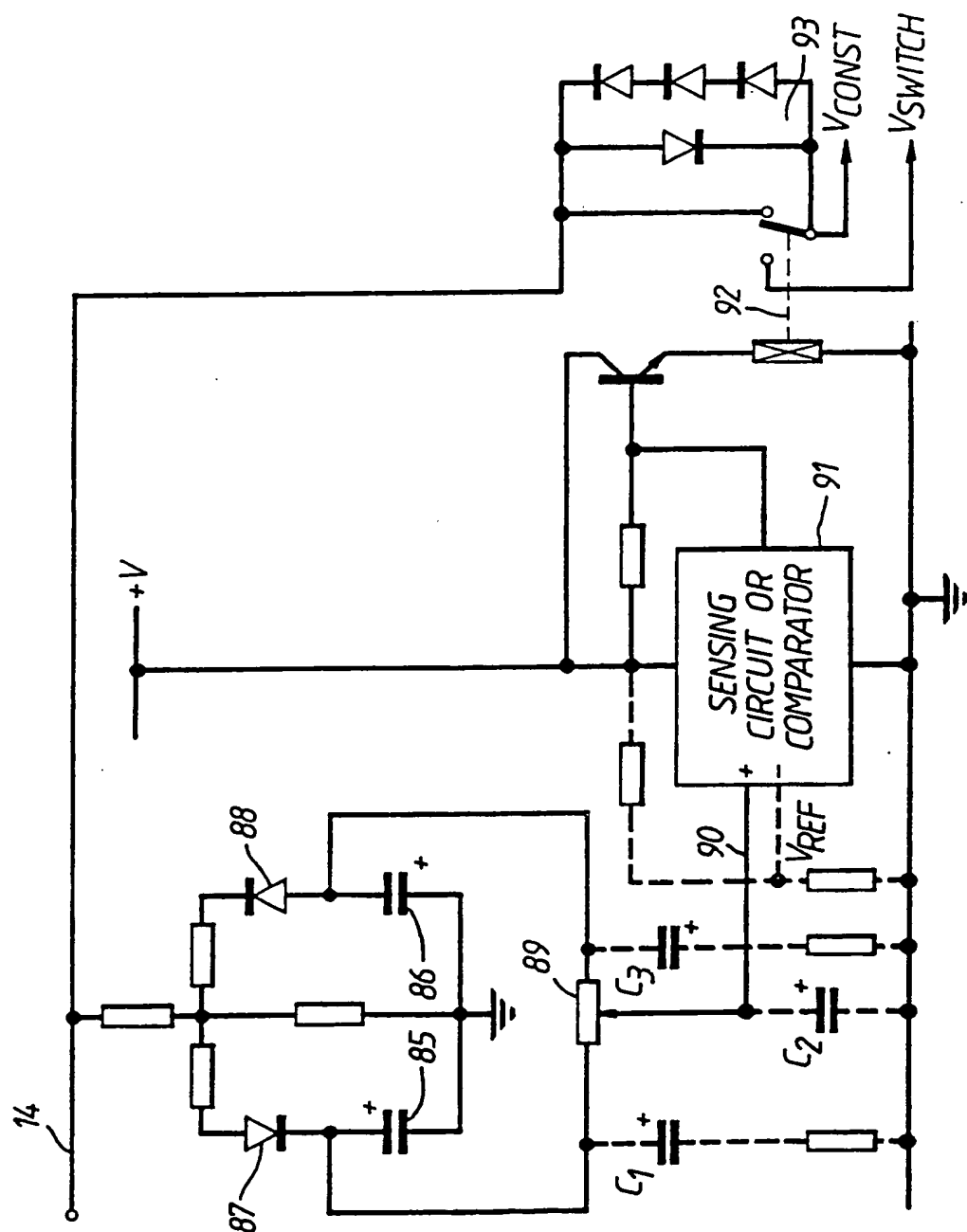
<u>SWITCH A</u>	<u>SWITCH B</u>	<u>RESULT</u>
L1	L1	FULL MAINS ON
L2	L1	DIODE PACK B IN CIRCUIT
L2	L2	FULL MAINS ON
L1	L2	DIODE PACK A IN CIRCUIT

TRUTH TABLE FOR FIG.5(c).

<u>SWITCH A</u>	<u>SWITCH B</u>	<u>RESULT</u>
L1	L1	DIODE PACK IN CIRCUIT
L2	L1	FULL MAINS ON
L2	L2	DIODE PACK IN CIRCUIT
L1	L2	FULL MAINS ON

Fig.6.

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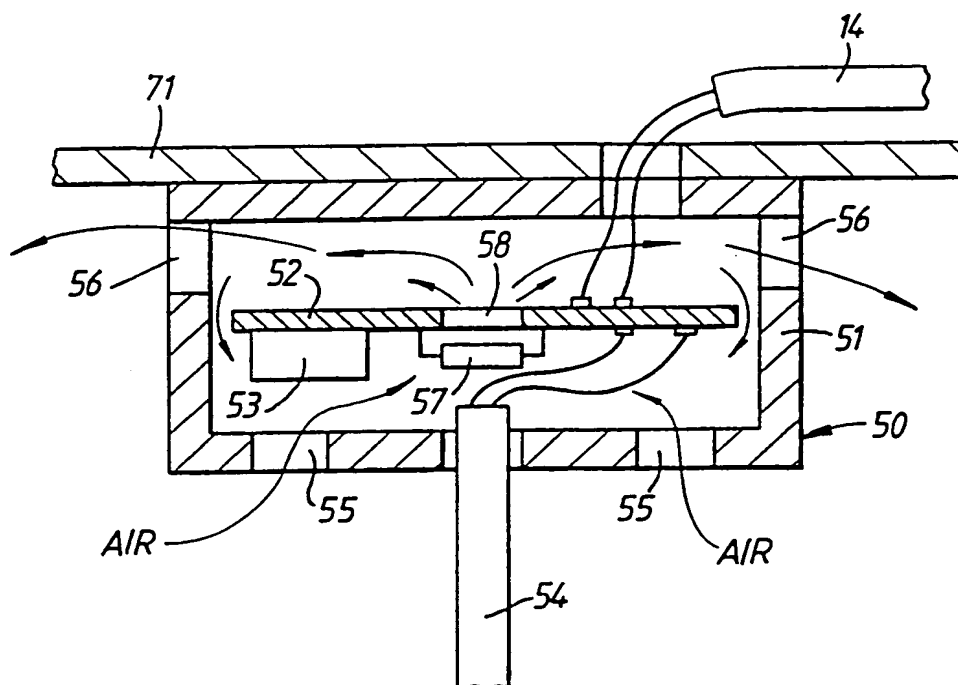


Fig. 8.

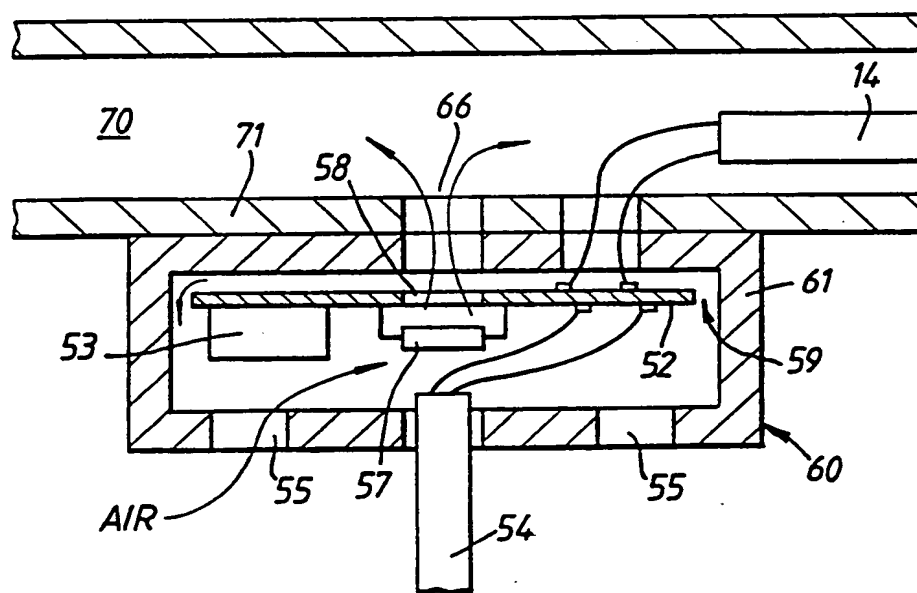


Fig. 9.

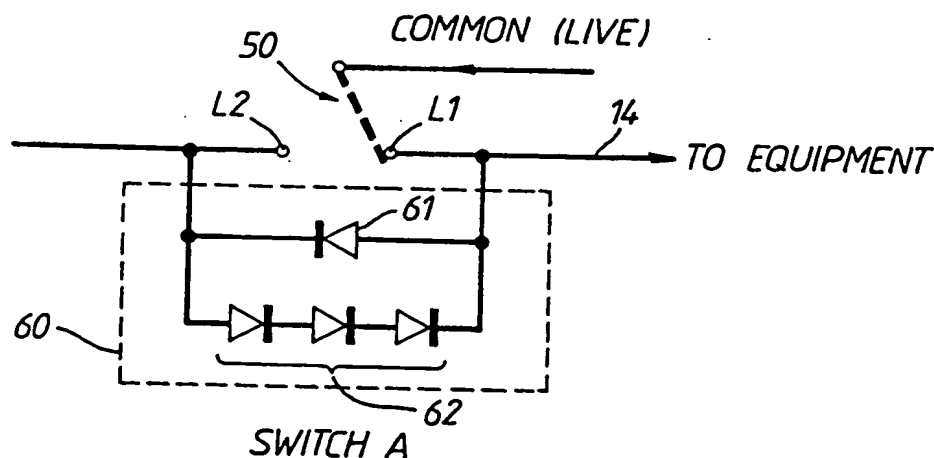




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : <b>H02J 13/00, G08B 17/10</b>		A3	(11) International Publication Number: <b>WO 93/17482</b>
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(22) International Filing Date: 26 February 1993 (26.02.93)		(74) Agent: CRAWFORD, Andrew, Birkby; A.A. Thornton & Co., Northumberland House, 303-306 High Holborn, London WC1V 7LE (GB).	
(30) Priority data: 9204416.3 29 February 1992 (29.02.92) GB 9218894.5 7 September 1992 (07.09.92) GB		(81) Designated States: AT, AU (Petty patent), BB, BG, BR (Utility model), CA, CH, CZ, DE (Utility model), DK, ES (Utility model), FI, GB, HU, JP (Utility model), KP (Inventor's certificate), KR (Utility model), LK, LU, MG, MN, MW, NL, NO, NZ, PL (Utility model), PT (Utility model), RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).	
(71) Applicant (for all designated States except US): SCAN-TRONIC LIMITED [GB/GB]; Perivale Industrial Park, Greenford, Middlesex UB6 7RJ (GB).		Published <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	
(72) Inventor; and			
(75) Inventor/Applicant (for US only): MOORE, Robert, William [GB/GB]; 5 Pen Yr Allt Rheola, Resolven, West Glamorgan SA11 4DS (GB).			
		(88) Date of publication of the international search report: 28 October 1993 (28.10.93)	

(54) Title: POWER SUPPLY AND SMOKE SENSOR FOR ALARM SYSTEM



## (57) Abstract

An alarm is provided in association with a ceiling rose. In order to provide the alarm with substantially continuous power while still allowing the light to be switched on/off the normal power supply lines are used together with a special light switch. Operation of the light switch produces a modification in the waveform of the AC power supplied to the ceiling rose. This modification is detected by a sensing circuit at the ceiling rose. The sensing unit controls the switching of the light. Preferably the AC power waveform is modified by creating an imbalance between the positive and negative half-cycles of the waveform. This imbalance may be compensated using a balancing circuit at the ceiling rose. By altering the polarity of the imbalance created in the AC waveform it is possible to signal to the sensing circuit that a further switchable unit, e.g. a ceiling fan, connected to the sensing circuit should be switched. If the alarm is a smoke alarm or the like then it is preferred to promote circulation of air within the casing of the unit, as well as to improve the draw of air into the casing, using a heating means and a special arrangement of air flow passages.

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 93/00409

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 H02J13/00; G08B17/10		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	G08B ; G08C ; H02J	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US,A,4 167 688 (BUREK ET AL) 11 September 1979 see the whole document ---	1-5,7-18
Y	DE,A,2 835 765 (LICENTIA PATENT-VERWALTUNGS-GMBH) 21 February 1980 see page 4, line 1 - page 6, line 20; figures 1-4 ---	1-5,7-18
Y	CH,A,196 446 (CHR. GFELLER AKTIENGESELLSCHAFT) 1 June 1938 see the whole document ---	3,12
	-/--	
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<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search 21 SEPTEMBER 1993		Date of Mailing of this International Search Report 01.10.93
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer WANZEELE R.J.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB,A,2 008 871 (ESB INTERNATIONAL CORPORATION) 6 June 1979 see page 1, line 61 - page 2, line 3 see page 2, line 42 - line 54; figures 1,4 ---	1,7-10, 15,16
A	GB,A,2 187 018 (COLIN ROBERT FRANCIS ET AL) 26 August 1987 see page 1, line 78 - line 130; figures 2,3A,3B ---	1,7-10, 15,16
A	DE,A,2 835 549 (RASMUSSEN) 1 March 1979  see the whole document ---	1-5, 10-14, 16-18
Y	FR,A,2 609 172 (HOCHIKI KABUSHIKI KAISHA) 1 July 1988 see page 5, line 21 - page 8, line 37; figures 1-6 ---	20-23, 25-28
Y	GB,A,1 528 671 (JOHN SCOTT NETHERWOOD BARKER) 18 October 1978 see the whole document ---	20-23, 25-28
Y	DE,A,1 915 906 (BERKELEY SCIENTIFIC LABORATORIES INC.) 6 November 1969 see page 4, line 15 - page 6, line 8; figure 2 -----	25

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB93/00409

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

1. Claims 1-19: Supplying switched power to a first output and continuous power to a second output.
2. Claims 20-28: Constructional details of smoke sensor.

The special technical feature of the first invention is:  
Supplying switched power to a first output and continuous power to a second output.

According to PCT rule 13 non unity a priori is detected for invention 2 which mainly deals with constructional details of a smoke sensor.

As a result, there is no technical link between the two inventions.



# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300409  
SA 70665

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4167688	11-09-79	None	
DE-A-2835765	21-02-80	None	
CH-A-196446		None	
GB-A-2008871	06-06-79	US-A- 4255746	10-03-81
		US-A- 4199754	22-04-80
		DE-A- 2849581	05-07-79
		JP-A- 54082199	30-06-79
		SE-A- 7811926	22-05-79
GB-A-2187018	26-08-87	GB-A, B 2155708	25-09-85
DE-A-2835549	01-03-79	None	
FR-A-2609172	01-07-88	JP-B- 4067679	29-10-92
		JP-A- 63163698	07-07-88
		AU-B- 605807	24-01-91
		CH-A- 674902	31-07-90
		DE-A- 3743737	07-07-88
		GB-A, B 2199941	20-07-88
		US-A- 4897634	30-01-90
GB-A-1528671	18-10-78	None	
DE-A-1915906	06-11-69	None	

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